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THESIS

MILITARY RETIREMENT AND WEALTH FORECASTING DURING DOD MANPOWER DRAWDOWN

by

Steven D. Mays

September 2013

Thesis Co-Advisors:	Thomas Housel
	William Sharpe
Second Reader:	Johnathan Mun

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This study focused specifically on the Marine Corps population, both to limit the scope of the study and to model the effects of the manpower reduction parameters used on its target population. The Marine Corps will utilize temporary early retirement authority (TERA), voluntary separation pay (VSP), enlisted retention, and Officer Continuation Boards as the parameters to reduce its end strength in the coming years.

The target population for this study was career-intentioned Marines officers defined as those Marines officers who voluntarily served beyond their initial contractual obligation by accepting a career designation status. Some will be separated prior to achieving traditional, 20-year, retirement eligibility.

This study will draw comparisons between promotion probabilities from known and theoretical data using Monte Carlo simulation and other statistical methods to generate a career-decision support tool for the affected population of Marines to make informed retirement planning decisions.

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MILITARY RETIREMENT AND WEALTH FORECASTING DURING DOD MANPOWER DRAWDOWN

Steven D. Mays
Major, United States Marine Corps
B.S., University of Maryland College Park, 2000

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September 2013

Author: Steven D. Mays

Approved by: Dr. Thomas Housel
Thesis Advisor

Dr.William Sharpe
Thesis Co-Advisor

Dr. Johnathan Mun
Second Reader

Dr. Dan Boger
Chair, Department of Information Sciences

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LIST OF ACRONYMS AND ABBREVIATIONS

CMC	Commandant of the Marine Corps
COLA	Cost of Living Adjustment
DFAS	Defense Finance and Accounting Service
DMMR	Defense Manpower Requirement Report
DoD	Department of Defense
FY	Fiscal Year
HQMC	Headquarters Marine Corps
LDO	Limited Duty Officer
MARCORSEPMAN	Marine Corps Separations Manual
MOS	Military Occupational Specialty
MPP	HQMC Manpower Plans and Policy Division
NDAA	National Defense Authorization Act
NPV	Net Present Value
ODSE	Operational Data Storage Enterprise
PMOS	Primary Military Occupational Specialty
PV	Present Value
TERA	Temporary Early Retirement Authority
TFDW	Total Force Data Warehouse
TSP	Thrift Savings Plan
VSP	Voluntary Separation Pay

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I. INTRODUCTION

A. BACKGROUND

The Department of Defense (DoD) will be facing significant budget cuts in the near future. In addition to reducing the funding for current and future programs, the DoD will taking preemptive action by also implementing a manpower drawdown plan, reducing the end strength for each component (Office of the Secretary of Defense, Personnel and Readiness [OSD P&R], 2012).

The Army is projected to cut approximately 27,000 troops, representing five percent of its current end strength of 570,000 soldiers (Murdock, 2012). The Marine Corps is projected to cut approximately 20,000 Marines from its end strength, representing approximately 10 percent of its current end strength of 202,000 (Murdock, 2012). The Air Force and Navy will make most of their budget cuts in their program spending and will see a less than one percent cut in their overall end strength (Murdock, 2012). The strategies, tools, and incentives that each component uses to reduce its end strength differ among the services.

This study focused specifically on the Marine Corps population in order to limit the scope of the study and to model the effects of the manpower reduction parameters used on its target population. The Marine Corps will utilize temporary early retirement authority (TERA), voluntary separation pay (VSP), enlisted retention, and Officer Continuation Boards as the parameters to reduce its end strength in the coming years (Headquarters Marine Corps [HQMC] M&RA, 2012).

The target population for this study was career-intentioned Marines officers defined as those Marines officers who voluntarily served beyond their initial contractual obligation by accepting a career designation status. Some will be separated prior to achieving traditional, 20-year, retirement eligibility.

The Marine Corps' attrition model is shown in Figure 1. The red-shaded region represents the additional Marines proposed to be cut beyond normal attrition as a result of the drawdown measures taken. This portion represents about 10 percent of the current officer population. The officer population at the lower tier is first and second lieutenants. The middle tier represents captains. The top tier represents majors, lieutenant colonels, and colonels. The top two tiers and a small portion of the bottom tier represent the affected population of career-intentioned Marines on which this study was focused. The general officer population is not projected to be affected by the Marine Corps' manpower reduction plan.

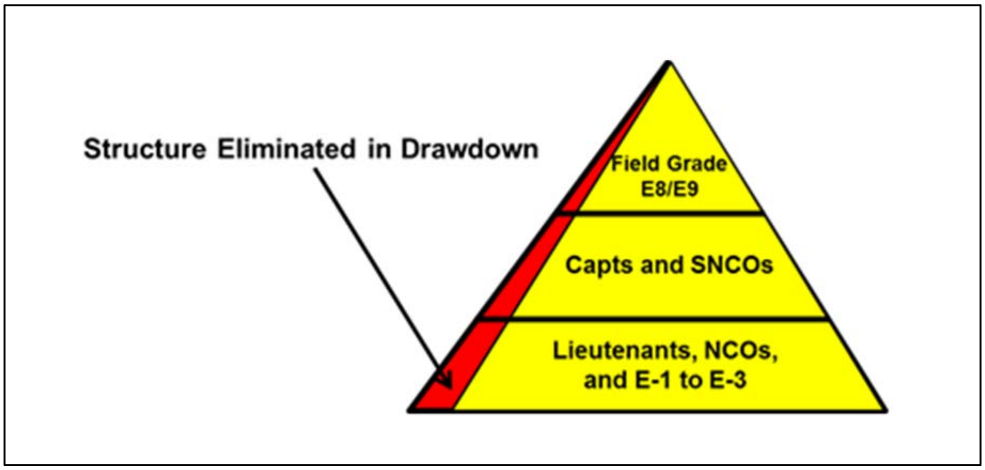

Figure 1. Marine Corps Drawdown (HQMC M&RA, 2012)

While continued service to reach the 20-year threshold for active duty retirement benefits is not guaranteed for any population of Marines, the Marine Corps' manpower drawdown represents unrealized additional risk for career-intentioned Marines that has yet to be quantified. Understanding the additional risk the drawdown parameters create will allow the affected population to make better-informed career decisions and simultaneously facilitate the Marine Corps' end strength reduction goals.

B. PURPOSE

This research did not intend to undermine the professional service of career Marines or reduce the purpose of continued military service solely to attaining retirement entitlements. Its goal was to acknowledge that there are considerations beyond military service that the potential affected population of Marines should consider when making career decisions and planning for retirement.

This research assessed and modeled the effects on the career longevity and wealth probabilities of active duty Marine Corps officers in the face of the various manpower drawdown parameters to be employed by the Marine Corps. This research will serve as a proof of concept for a decision support tool that will empirically estimate the additional risk to career longevity and retirement that individual Marines are exposed to as the result of the Marine Corps' drawdown plan.

The results of this study will allow the potentially affected members of the population the opportunity to statistically forecast their career longevity. Existing retirement investment theory generally focuses on the "end of working age" retirement population. This study modeled the population's career investment potential to enable informed career and retirement planning decisions during the careers of its members. This research bridges the gap between the age of military retirees and traditional retirees.

Based on the results of past officer promotion boards, a career path probability tree was created and used to determine the most likely career profiles of Marine officers. The historical military pay tables were used to determine how members of the affected population should adjust their investment behavior from a determined retirement baseline to mitigate the impact of the drawdown on retirement financial security.

While this research focused on the subpopulation of Marine Corps officers, the results may have merit throughout the DoD as well as other organizations with similar retirement structures and pensions. The methodological approach also highlighted the ability to make risk decisions in an uncertain environment.

C. RESEARCH QUESTIONS

What is the baseline projected wealth of a traditional 20+ year defined benefit retirement for career Marine Corps officers?

What is the risk exposure to the affected population necessary to achieve the baseline projected wealth?

What are the projected effects of the various Marine Corps drawdown parameters on the longevity of the affected population of Marine officers?

What are the effects of the various Marine Corps drawdown parameters on the expected career wealth potential of the affected population of Marine officers?

D. BENEFITS OF STUDY

The statistics that drive this model can be updated each year as promotion and attrition results become available. Newly accessed Marines in the future years can use the model to better plan for retirement earlier in their careers without strictly relying on nonguaranteed military retirement compensation and traditional investing for future wealth. This study was constrained to the parameters that the Marine Corps has chosen to reduce its end strength. However, member of other services and employees in private industry with similar retirement structures and force shaping may benefit from this study.

E. SCOPE

This study only considered the career paths and expected earnings of active duty Marine Corps officers who have demonstrated a desire to make the Marine Corps a career. For the purpose of this study, a career-intentioned officer was defined as an officer who has been offered and has accepted career designation as reported in the Total Force Data Warehouse (TFDW). This study will have application to other services and subpopulations.

This specific population was chosen because the career path of active duty Marine Corps officers is well defined and generally linear. Unrestricted active duty officers are accessed as second lieutenants and remain unrestricted active duty officers for the duration of their careers until discharged from active duty either by separation or retirement. While the study may have merit to the other populations that exists within the Marine Corps, there are too many career path possibilities to be able to model within the limited scope of the study.

Enlisted Marines not only have the opportunity to serve their entire career in the enlisted corps, they also have the ability to transition into the warrant officer or commissioned officer corps at widely varying points in their careers. Likewise, warrant officers are accessed from the enlisted population and may transition to restricted commissioned officers. The high degree of variation in the enlisted and warrant officer career paths would have made the scope of this study too large to be able to account for all of the career path possibilities.

Additionally, a limited forecast of retirement investing was considered for this study. The number of investment options and outcomes was too high to be able to accurately model. Once the effects of the Marine Corps' drawdown plan are understood, they can be applied to the career paths of other populations of Marines that were not as easily modeled.

F. METHODOLOGY

This study utilized existing data from the Marine Corps' Total Force Data Warehouse (TDFW), the Marine Corps' official data repository which contains more than 30 years of historical manpower data and personnel information (Total Force Data Warehouse [TFDW], n.d.). The historical population of career-designated Marine officers was queried for the available years to determine the annual number of career-designated officers who were discharged from active duty prior to achieving retirement eligibility. This determined the baseline attrition levels prior to the Marine Corps' drawdown implementation. The career paths and longevity of a sample of the career-designated officers was queried as well.

A career longevity and wealth generation model was created using a modified Microsoft Excel-based retirement funding model developed by Real Options Valuation, Inc. (Mun, 2006). The model had an underlying investment model to forecast expected wealth growth and the required contribution levels throughout the officer's career, and beyond, during the working years prior to the natural retirement age. The model used a Monte Carlo simulation of career longevity and promotion probabilities to determine the distribution of outcomes. Historical military pay schedules were gathered from 1965 to 2013. In addition to estimated pay schedules for FY 2014 through FY2017, future pay schedules were forecasted out to 2037 using the best statistical fit of known historical rate increases from 1965 to 2013.

The promotion probabilities were established for each grade and fiscal year using a probability tree based on available statistics from the results of the Marine Corps officer promotions boards from 1993 to 2013 provided by the Promotions Branch, Manpower Management Division, Manpower and Reserve Affairs, Headquarters USMC. The Marine Corps' drawdown parameters were assessed from the model by determining the percentages of the affected population that met the requirements for the requisite parameter. Future promotion probabilities were forecasted based on the statistical distribution of the known year's results as well the Marine Corps' known manpower reduction goals for the subsequent years.

The longevity of an officer's career was based on a TFDW query of officer accessions and separations or retirements from 1993 to 2013. Once the longevity and promotion probabilities were known, a stochastic model of the expected value of the career wealth for Marine officers was generated based on those statistical probabilities and the officers' expected career longevities. The investment model was applied to the affected population through Monte Carlo simulation to create a distribution of outcomes to be analyzed in Chapter IV.

G. PROBLEM STATEMENT

The Department of Defense is financially constrained by congressional mandates for its authorized end strength (Murdock, 2012). Since 2000, the end strength numbers have grown to support ongoing contingency operations (Gates, 2011). With the ending of combat operations in Iraq and Afghanistan and in anticipation of projected defense budget reductions in the near future, the DoD is planning to significantly reduce its end strength during 2013 through 2017 (Murdock, 2012). Attrition is a normal function of military manpower shaping (HQMC M&RA, 2012). A drawdown will force out many qualified career-intentioned officers who would otherwise prefer to continue to serve until retirement eligible. The problem is that many career servicemen who planned for a traditional military retirement may not know how to reassess or adjust their retirement plan when faced with an unexpected separation resulting from a drawdown or involuntary separation.

II. LITERATURE REVIEW

A. MARINE CORPS MANPOWER SHAPING

1. DoD Perspective

With the national debt approaching $17 trillion, the federal government is under fire to find ways to curb the momentum in federal spending (Murdock, 2012). With 20% of the total federal budget, the DoD has been the focus of much attention to reduce federal spending (OSD P&R, 2012). While the Air Force and the Navy are looking into reducing spending for programs to lessen the burden, the Army and Marine Corps are targeting manpower reductions (OSD P&R, 2012). The Marine Corps uses manpower force controls and natural attrition as a way to maintain its manpower end strengths and desired military occupation combinations (HQMC M&RA, 2012). While much work exists to model and forecast natural attrition within the various components (CBO, 2006; Warner, 2008), very little research has focused on the effects of the self-imposed attrition the force drawdown represents. Because of this lack of research, the Marine Corps has proposed a number of drawdown parameters to be aggregately implemented in series until the desired end strength is reached in fiscal year 2016 (HQMC M&RA, 2012).

2. Marine Corps Drawdown Approach

Each fiscal year the DoD submits its Defense Manpower Requirements Report in preparation for the President's Budget (OSD P&R, 2012). The report documents the military and civilian manpower requirements necessary to support the nation's military capabilities for the fiscal year the report was generated and forecasts the same requirement out to five fiscal years (OSD P&R, 2012). In the 2012 report, the Marine Corps forecasted a reduction in force by almost 20,000 Marines by fiscal year 2016 (OSD P&R, 2012; HQMC M&RA, 2012). This includes a three percent reduction in the field grade officer end strength and a 13 percent decrease in the company grade end strength between fiscal years 2011 and 2016 (OSD P&R, 2012). The combined result will be a 10 percent reduction in the end strength for active duty officers. While the Marine Corps has promoted a "keeping the faith" (HQMC M&RA, 2012) approach with respect to its career officers to allow them to at least continue service until achieving retirement eligibility, the reality is that there will be a number of career-designated officers who will be offered early retirement or involuntarily separated from the Marine Corps prior to reaching eligibility for a statutory retirement. The number and effect is unknown. This sudden career shift will impact the retirement income of this affected population and require additional planning and foresight to account for this new risk to its members' career longevity and livelihood during their retired years.

a. Marine Corps Career Designation

The Marine uses career designation as a force-shaping tool (HQMC M&RA, 2012). It is a highly competitive process with the goal of retaining only the best-qualified officers (HQMC M&RA, 2012). Career designation has become increasingly more competitive as the Marine Corps begins to downsize the force to align with the DoD goals. The career designation rates for the previous boards are shown in Table 1. A declining rate in each competitive category was noted.

Table 1. Marine Corps Career Designation Rates (From McNeil, 2013)

CD BOARD	CSS	GRN	AV GRN	LAW	AVIATION
FY11 ORB #1	65%	65%	65%	ALL QUALIFIED	ALL QUALIFIED
FY11 ORB #2	65%	65%	65%	ALL QUALIFIED	ALL QUALIFIED
FY12 ORB #1	60%	60%	60%	85%	95%
FY12 ORB #2	60%	60%	60%	85%	95%
FY13 ORB #1	55%	55%	55%	85%	95%

b. Career Designation Process

When a career designation board convenes, all eligible officers are divided into five competitive categories: ground (GRN), combat service support (CSS), aviation ground (AV GN), law, and aviation (McNeil, 2013). The ground category includes the 0302 Infantry and the 1802, 1803, and 0802 military occupational specialties (MOSs). The CSS category includes 0180, 02XX, 0402, 0602, 1302, 3002, 3404, 4302, and 5803 MOSs. The Aviation Ground category includes the 6002, 6602, 7204, 7208, 7210, and

7220 MOSs. The Law category consists of the 4402 MOS, and the aviation category consists of all the 75XX MOSs.

The total number of officers selected for career designation in each competitive category is determined by the HQMC Manpower Plans and Policy Division (MPP), which determines the retention percentages needed in each category to keep the Marine Corps optimally operational (McNeil, 2013). MPP ensures that the officer population for the active duty officer corps for each rank and year of service aligns with the opportunities for promotion opportunities to the rank of major. An officer who is selected for career designation and remains in good standing, is more likely than not to have the opportunity for a career through retirement (McNeil, 2013). The imposed drawdown parameters lessen that likelihood.

B. RETIREMENT BEHAVIORS

1. Age

Maestas (2009) and Gustman and Steinmeier (2009) showed that people who retire in their early 50s often reenter the workforce or "unretire" either because of a lack of fulfillment with being retired or because of lack of financial security to support their retirement. Military members reach retirement eligibility after 20 years of active service (Age and Service Requirements, 2006). On average, they retire at age 41 for enlisted members and at 45 for officers (Warner, 2008). The traditional or full retirement age for nonmilitary workers is determined by the number of years a person works. Workers who entered the workforce after 1960 reach full retirement age for social security benefits at age 67 but may take benefits as early as age 62 (SSA, 2013). There exists a 20- to 25-year gap between the average retirement age of military officers and the full retirement age where Maestas (2009) proposed workers will continue to work in some capacity.

2. Financial Literacy

Lusardi and Mitchell (2011) studied the financial literacy of the U.S. population. They conducted a three question survey of 1,500 American adults to ascertain the level of understanding people have with the basic economic concepts of risk, diversification, and inflation. More than 35% of the respondents in the 35 to 50 year-old group indicated that they did not know the answer to one or more of the basic questions (Lusardi & Mitchell, 2011). A low level of financial literacy leads to poor financial decisions (Hurd & Rohwedder, 2010) such as choosing mutual funds with high fees; selecting high-cost mortgages; and selecting high-cost pension managers (Lusardi & Mitchell, 2011); this is the age group that encompasses a vast majority of military retirees. They determined that those with graduate and postgraduate degrees scored better than all other respondents (Lusardi & Mitchell, 2011). All officers in the target population of this study are college graduates at the undergraduate level at least. The other dividing factors they considered beyond education included sex, race, and age.

In addition to financial literacy among investors, studies have focused on the factors that influence the investment preferences and risk tolerances of individual investors. Utility functions are a way to capture the preferences of an investor as well as to determine the amount of risk they are willing to assume with the ultimate goal of achieving greater wealth (Sharpe, 1970; Norstad 1999a). Gustman and Steinmeier (2009) observed the necessity for dynamic modeling to account for changing retirement behaviors. A single utility function may be too simplistic and lead to biased estimates (Gustman & Steinmeier, 2009). The affected population of Marines who were the focus of this study was generally younger than the general population of working-age retirees upon which much of the theory is based. Lusardi and Mitchell (2011) showed that the measure of acceptable risk an individual investor will accept is inversely related to age. Lusardi, Mitchell, and Curto (2012) asserted that those who are less financially literate are less likely to plan for retirement. This finding highlights the need for those in the affected population of this study to consider their career choices and retirement investments as early as possible to mitigate the negative effects of poor retirement planning.

3. Risk

The differences between risk and uncertainty are often misunderstood. Mun (2006) defined risk as that which one bears as the outcome of uncertainty and stated that uncertainty may be reduced with the passing of time or as events occur over time. The risk over a given time horizon may remain constant, but as the time horizon increases, the level of uncertainty will increase (Mun, 2006). In formalizing portfolio theory, Sharpe (1970) proposed that investors make investment decisions about a group of securities with different risk levels to minimize the overall risk exposure of the portfolio when compared to an individual investment. The risk of a portfolio is directly proportional to the standard error of the probability distribution of the portfolio's performance outcomes (Sharpe, 1970). An individual investor will choose a portfolio that maximizes the expected utility of a portfolio (Sharpe, 1970 and Norstad 1999b). Loewenstein, O'Donoghue, and Rabin (2003) asserted that to model optimal investment decision making requires a prediction of future tastes. They introduced projection bias as a variable that should be considered in utility modeling that accounts for dynamic changes in investor preference over time or as the result of major life changes. If not accounted for, projection bias can cause an investor to underappreciate changes in investor preference and thus work more years and retire later than planned (Loewenstein et al., 2003).

Career Marines who are involuntarily separated from active duty will receive a separation payment commensurate with their years of service and must make decisions about how to invest this payment in order to reach their original retirement financial goals without the contribution of retirement compensation. With a large lump sum payment in hand, a Marine's individual preference and discount rate will play a role in how much he or she is willing to invest. This must be considered. Deichert (2006) determined that Marines have different discount rates that correlate to years of experience (rank or age), family composition, and military occupation. Additionally he found that the temporal changes in discount rate directly corresponded to a Marine's experience level.

C. MILITARY RETIREMENT COMPENSATION

1. Direct Compensation

Since 1986, the defined benefit compensation for Marine retirees is an annuity payment computed at 2.5 percent of the average of the highest three years annual basic pay times years of service with a minimum of 20 years of service. This will be paid for the remainder of the retiree's life (Age and Service Requirements, 2006). Compensation for Marines who are involuntarily separated is computed as a one-time severance payment equal to no more than twice the monthly basic times the years of active service with a maximum credit for 12 years of service (CMC, 2001). The minimum amount of retirement compensation is 50 percent of the Marine's high three average basic pay for 20 years of service with an increase of 2.5 percent for each subsequent year served (Age and Service Requirements, 2006). The maximum amount is 100 percent commensurate with 40 years of service but only occurs in rare cases for senior general officers and senior enlisted Marines (National Defense Authorization Act [NDAA], 2007).

In addition to the compensation stipulated above, military retired pay is protected against inflation through the use of cost of living adjustments (COLA). The COLA is subsidized by the government, per 10 U.S.C. Section 1401a, and augments retired military pay. Eligible retirees may also begin drawing social security benefits as early as age 62.

2. The Thrift Savings Plan

The Federal Employees' Retirement System Act of 1986 extended the defined contribution, or Thrift Savings Plan (TSP), to military members. The TSP allows military members to invest all or a portion of their basic pay into a mix of funds with varying risk levels. While the TSP offers investors more hands-on control over their retirement planning, Lusardi et al. (2012) determined that most retirees lack the financial sophistication to be able to make decisions regarding the management of defined-contribution plans.

3. Indirect Compensation

Retirees can choose to live in any of the 24 states that exempt military retirement income from state tax. In a worst-case scenario, such as California, income tax can impose as much as a 9.3 percent annual burden on the retiree. There are several states that offer a partial tax benefit the military retirees. Retirees under the age of 65 are eligible for Standard TRICARE with no extra cost. Additionally, those retirees over 65 are automatically enrolled in TRICARE for Life, which covers eligible non-Medicare expenses. The combined benefits offered through TRICARE and Veterans' Affairs healthcare make more than half of the deferred compensation retirees receive.

4. Sanctuary Protection

Paragraph 12646 of Title 10 U.S.C. addresses the retention of active duty officers who have accrued at least 18 but fewer than 20 years of service. These officers are within two years of retirement eligibility and are considered to be in a sanctuary status. They may not be involuntarily separated until retirement eligibility is reached. The sanctuary status does not guarantee promotions, promotion eligibility, or the opportunity to serve beyond 20 years (HQMC M&RA, 2012).

D. USMC MANPOWER REDUCTIONS GOALS

The Marine Corps is seeking to reduce its end strength by 20,000 Marines by fiscal year 2016. It has proposed temporary early retirement authority (TERA), voluntary separation pay (VSP), enlisted retention, and Officer Continuation Boards, as well as a reduction in promotion opportunities as the parameters to reduce its end strength. The parameters will be implemented in series and aggregated until the desired end strength is achieved. The Marine Corps drawdown plan will result in an overall 10 percent reduction in its officer corps with a majority of those coming from the company grade and field grade ranks (HQMC M&RA, 2012).

1. Temporary Early Retirement Authority (TERA)

The National Defense Authorization Act (NDAA) of 2012 reauthorized service components to offer early retirement to its active duty members who have completed at least 15 years of active service but fewer than 20 years. This authority is enacted at the discretion of the service components and is not an entitlement to service members (NDAA, 2012). TERA retired pay is computed using the same formula that is used for conventional 20 year retirements, but it includes an early retirement reduction factor based on the number of months the member retires with fewer than 20 years of service

TERA Retired = High-3 Active Duty Pay x Percent Multiple x Reduction Factor

Reduction Factor = 1/12th of 1% for each month retired early

2. Voluntary Separation Pay (VSP)

In addition to TERA, the 2012 NDAA authorized service components to offer VSP to its active duty member. Each service component secretary will determine the amount of compensation members will be paid under this program (1175 10 U.S.C., 2006). Under the purview of the Secretary of the Navy, the Marine Corps has established the program for active duty officers who hold or have been selected for promotion to the rank of major. Eligible officers must have completed at least 6 years of active service but fewer than 20 (HQMC M&RA, 2012). VSP provides a lump-sum monetary payment to eligible officers who voluntarily separate from active duty and will be computed by the formula below:

VSP = 0.20 x Year of Active Service x Annual Basic Pay

3. Officer Continuation Boards

The final measure for the Marine Corps' drawdown plan for the officer population is the continuation board. Each year upon the completion of the officer promotion boards, the boards will reconvene to consider the continued service of captains and majors who have been twice passed over for selection to the next grade (HQMC M&RA, 2012). The major continuation board considers those officers who are subject to involuntary discharge and will have fewer than 18 years of service (HQMC M&RA, 2012). The captain continuation board considers prior enlisted captains who have at least 15 years of active service but fewer than 18 years of active service (HQMC M&RA, 2012). Those officers selected for continuation will serve on active duty until they achieve 20 years of active service and will be retired (HQMC M&RA, 2012). Those not selected for continuation will be involuntarily separated at their planned separation date (HQMC M&RA, 2012).

III. MODEL FORMULATION

A. OVERVIEW

The model was created using Microsoft Excel and the Risk Simulator add-in from Real Options Valuation, Inc. Before the effects of the Marine Corps' drawdown parameters were assessed, a baseline career probability was derived to determine what the attrition rates were for the affected population. The model assumes that the career designation process has occurred. It has historically coincided with or been predicated on promotion to the rank of captain.

B. INPUTS

The parameters for the model's input are shown Figure 2. The inputs for were the Marines accession date, starting grade, years of prior active service, age, and the drawdown parameters implemented by the Marine Corps.

Input Data	
Date Commissioned	1/30/2000
Starting Grade	O1E
Years of Prior Active Service	6
Age at Commissioning	26
Natural Retirement Age	59
Natural Life Age	74
Inflation Rate	3.0%
Interest	8.0%
Replacement Ratio at Retirement	70.0%
Initial Retirement Savings	$5,000
Terminal Wealth Goal	$0

Figure 2. Model Input Variables

1. Date Commissioned

While most Marine officer are accessed as second lieutenants, officers who were commissioned with more than four years of active service as an enlisted Marine have a higher base pay as a company grade officer. The "Date Commissioned" is the date that the Marine was accessed into the officer corps. This variable does not take into account prior service years.

2. Starting Grade

The "Starting Grade" is the initial rank to which the officer was commissioned. In line with assumptions described below, the only available options for the model are O1 or O1E. Officers with fewer than four years of prior active service will select O1. Officers with four or more years of active service will select O1E and enter the appropriate number of prior service years in the next variable.

3. Years of Prior Active Service

The officer will enter the total number of creditable years of active service completed prior to the date of commissioning. The "Years of Prior Active Service" is used with commissioning date and starting grade to determine the "Starting Base Pay" in the model's output. If a starting grade of O1E is chosen, the officer will enter at least 4 for this variable to calculate the proper starting base pay.

4. Ages

The "Age at Commissioning" is the officer's age in years on the date of commissioning. The "Natural Retirement Age" is the age beyond military retirement age to which the officer will continue to work. Together these ages are used to compute the investment contribution level necessary to fund the simulated retirement until "Natural Life Age" or terminal age.

5. Inflation and Interest Rates

For each iteration of the simulation, the model will choose an expected inflation rate and rate of return for investments from a normally distributed sample of rates. These rates will be used to adjust the forecasted income and investment earnings during the periodic payment. Investing strategy was beyond the scope of this study. The standard deviations of the normal distributions provide a measure of volatility in the forecasted earnings to prevent deterministic forecasting of investment outcomes.

6. Replacement Ratio at Retirement

The "Replacement Ratio at Retirement" variable represents the percentage of monthly working income that will be needed to maintain the desired standard of living in the retirement years. This ratio is used to pay for taxes, living expenses, and discretionary spending. This percentage will be taken from the highest monthly income before retirement and withdrawn, inflation adjusted, from the accumulated retirement savings each month.

7. Initial Retirement Savings

"Initial Retirement Savings" is the amount of money that the officer has accumulated prior to being commissioned and will be applied toward retirement investments. This can be adjusted depending on the career starting point of the simulation. It is currently defaulted to coincide with savings accumulated on the accession date.

8. Terminal Wealth Goal

The "Terminal Wealth Goal' is the amount of money that the officer desires to be left over at the terminal age. This will be used to determine the contribution rate necessary to make the Terminal Wealth in the model's output equal to this amount.

C. OUTPUTS

The pertinent outputs of the model are the estimated career longevity, monthly contribution rate, discharge age, and forecasted VSP compensation. The outputs of the simulation are shown in Figure 3 below. The output variables not highlighted were used only for intermediate computational purposes and were not analyzed in Chapter IV. The yellow-highlighted regions will generate a distribution of the simulated results that will be analyzed in Chapter IV.

Simulation Results	
Starting Base Pay	$2,572
Contribution Ratio	24.9%
Net Career Military Salary	$2,533,907
Miliary Career Length	24.3
Military Discharge Age	44
Contribution Amount	$640
Terminal Wealth	$986,583
Hi Three Base Pay	$4,814
Retirement Multiplier	60.9%
Max Base Pay	$4,843
Max Monthly Salary	$6,413
VSP Amount	$0
TERA Hi Three Base Pay	$0
Sanctuary Years	0.00

Figure 3. Simulation Results

1. Starting Base Pay

Given the officer accession date, starting grade, and years of prior service, the model performs a lookup of the 1996 pay table. Pay increases from 1996 until the accession year are added to this amount and the base pay for the initial pay grade and years of service is returned. The same lookup is performed during the career simulation to ensure the correct pay is accumulated each month, accounting for promotions.

2. Contribution Ratio and Amount

The "Contribution Ratio" is the percentage of the monthly pay that the officer needs to invest each month in order to reach the desired retirement wealth goal. The Excel Goal Seek function is used to return the appropriate percentage. This percentage is multiplied by the officer's initial base pay to determine the contribution amount.

3. Net Career Military Salary

The "Net Career Military Salary" variable returned the expected aggregate career salary. It was solely determined by the accumulated base pay and did not include entitlements and allowances.

4. Military Career Length

The "Military Career Length" variable created a distribution of the career longevity, in years, for each iteration of the simulation. It was measured by adding the years of prior active service to the years of commissioned service. This was used to distinguish which drawdown parameter the officer will be subject to. Officers with 20 or more years of service were eligible for military retirement. Majors with fewer than 20 years of service were eligible for VSP. Officers with fewer than 20 but more than 15 years of service were eligible for TERA.

5. Military Discharge Age

The "Military Discharge Age" variable returned the simulated age at discharge. It was computed by adding the years of commissioned service to the accession age. The variable created a distribution of the discharge ages, in years, for each iteration of the simulation. This variable was used to determine the age to begin adjusting the income level during the working years from military compensation to civilian compensation.

6. Terminal Wealth

The "Terminal Wealth" variable returned the expected wealth at the terminal age. The Goal Seek function will attempt to force this amount to be equal to the terminal wealth goal from the input and return the necessary contribution rate. It is based on investment growth during the working years and consumption during the retired years. A positive or zero value is acceptable. A negative value is indicative of an underfunded retirement.

7. Hi Three Base Pay

If the officer is retirement eligible during the simulation run by accruing at least 20 years of total service, the model will return the average of the highest three months of base pay. The model returns zero otherwise. A portion of this amount, determined by the multiplier, will be accumulated each month as income in the retired years until the terminal age is reached.

8. Retirement Multiplier

The models returns the appropriate multiplier based on years of service. This is computed as 2.5 multiplied by the total number of years of active service for officers who have at least 20 years of service.

9. Max Base Pay

The model returns the maximum monthly salary earned during the active military career. This is used to compute the VSP amount if the officer is eligible.

10. Max Monthly Salary

The model returns the highest overall salary earned before retirement. A portion of this amount, determined by the replacement ratio, will be withdrawn each month during the retired years to account for monthly expenses and discretionary spending.

11. VSP Amount

If the officer's final rank before discharge is major (O4) and the officer has fewer than 15 but more than six years of service, the model returns the amount of VSP authorized. The model returns zero otherwise

12. TERA Hi Three Base Pay

Officers who have accrued at least 15 years but fewer than 20 years of active service will be eligible for TERA. If the officer is eligible, the model returns the amount of TERA authorized if eligible based on the statutory high three determination with a reduction factor included. The model returns zero otherwise

13. Sanctuary Years

If the simulation returns career longevity between 18 and 20 years, the model returns the number of years needed to reach 20 years. This amount is added to time in grade of last pay grade in the simulated career.

D. ASSUMPTIONS

1. Staff Judge Advocate

This model assumes that all Marine Corps officers are accessed as second lieutenants and follow the same linear career path. Officers accessed through the Marine Corp law programs are accessed as second lieutenants, but have the opportunity to advance their time in service and seniority for promotion while completing their law school education. It was determined from the initial TFDW queries that this deviation from the normal career progression for this community represents a small number of the total population of officers accessed. However, the length of time that is spent completing the law school requirements in an inactive status will significantly affect their modeled career paths and earnings. This population was, therefore, excluded from the sample population. This excluded subpopulation comprised those second lieutenants with the military occupational specialty (MOS) Judge Advocate, designated with a value of "4401" or "4402" in the "PRIMARY_MOS" data field.

2. Limited Duty Officers

Limited duty officers (LDO) are restricted line officers who are accessed from the warrant officer community. Their commissioning track begins at the rank of Captain (O3E). LDO are rarely, if ever, discharged from the Marine Corps prior to achieving retirement eligibility due to the prior enlisted service and time as a warrant officer. While the study may have been pertinent to the LDO community, LDOs were excluded from the sample population. This excluded subpopulation was designated as those second commissioned officers with a non-null value in the "DATE_RANK_LDO_1ST_COMMISSION" data field in the TFDW query.

3. Present Value

This model assumed the initial commissioning as a second lieutenant as the starting point for all officers to consider their retirement plan. While Marines may consider their career longevity and retirement planning at different points in their career, having a similar starting point facilitates comparison in the analysis. Similarly, since the value of money will change over time and the longevity of the modeled careers will differ, all monies will be expressed as present value (PV) sums to facilitate comparisons of careers with different time horizons.

4. Allowances

Marines receive entitlements such as Basic Allowance for Subsistence and Basic Allowance for Housing. These entitlements are quite sizable and vary based on the Marine's location, grade, and dependent status. For this study it was assumed that Marines will use their entitlements for the purposes for which they were intended and will not be counted as income that could be invested for retirement.

5. Negative Career Progression

The career profiles modeled in this study assume a non-negative career progression. While there may actual instances of demotions within the population, it is assumed that the total number of negative career progressions is not large enough compared to the number of officers in the affected population.

6. Career Designation

The purpose of this study is to determine the effects of the Marine Corps drawdown on the population of career-intentioned officers. The assumption is that the officers modeled in the study have already been offered and have accepted career designation. The purpose of career designation as well as its process has been discussed as it relates to officer attrition. Career designation will not be modeled as a part of this study.

E. BASELINE CAREER STATISTICS

Before the outputs of the theoretical model could be validated, an understanding of the current and historical career flows was correlated with the model's career flow outputs. Each fiscal year, the Marine Corps provides inputs into the DoD's annual *Defense Manpower Requirement Report* (DMMR). The report shows the officer flows for the previous and current fiscal years, and forecasts out the manpower flows for five fiscal years. The average manpower flows for each grade O1 thorough O6 fiscal years 1996 through 2013 were observed to determine the actual number of officers who were involuntarily separated. Since the beginning of FY2004 both voluntary separations and involuntary paid separations were combined and reported as one number for each grade.

The precise number of officers who were involuntarily separated could not be derived from the data provided by the DMMR. A query of the TFDW was used to determine the numbers of officers in each grade who were released from active duty involuntarily. The baseline was evaluated prior to conducting the analysis.

F. PROMOTION PROFILE

All policies within the DoD regarding the promotion of active duty officers are governed by Title 10 of the United States Code. Section 523 of the law determines the number of officers in each grade below the rank of brigadier general as well as the aggregate number of officers allowed. The Manpower Plans and Policy (MPP) division of Headquarters Marine Corps (HQMC) establishes the manning levels for each grade each fiscal year. The Marine Corps policy for officer promotions is to "promote the best and most fully qualified” from all promotion-eligible officers in a given rank without regard to primary military occupational specialty (CMC, 2001). The career designation process ensures that manning levels for each PMOS are adequate (CMC, 2001). While this approach has led to some periodic shortfalls in some PMOSs (McHugh et al., 2006), it ensures that promotion probabilities are not a function of PMOS. Since this study assumes that officers in the affected population have been offered and accepted career designation, PMOS is not necessary and will not be used in this study to determine promotion probability.

1. Promotion Probabilities

Table 2 shows the Marine Corps officer promotion statistics from fiscal year 1993 to 2013. The promotion rates have been close to these averages since the early 1990s. Adjustments for increases or decreases to the manning levels for each grade are achieved by altering the time in grade requirement for eligible officers that a promotion board will consider.

Table 2. Average Promotion Statistics FY1993–FY2013

	Promotion Rate			Time in Grade (Years)			Time in Service (Years)			Age (Years)		
Rank	Above Zone	In Zone	Below Zone	Above Zone	In Zone	Below Zone	Above Zone	In Zone	Below Zone	Above Zone	In Zone	Below Zone
Col	2.8%	51.0%	0.0%	5.6	5.6	0.0	22.0	22.0	22.0	44.8	43.7	0.0
LtCol	5.1%	67.1%	0.0%	6.5	4.6	3.6	16.6	15.4	27.6	40.0	38.4	46.8
Maj	2.9%	84.5%	0.5%	5.6	4.5	3.4	11.3	10.8	11.5	34.7	33.7	34.5
Capt	1.1%	98.4%	0.0%	2.8	1.4	0.0	6.1	4.8	0.0	29.6	27.8	0.0

Based on the promotion probabilities extracted above, a probability tree was generated for a newly commissioned second lieutenant (see Appendix A). A sampling of the available promotion probability statistics from 1993–2013 was used to determine the promotion probability at each grade as well as the average time in grade that a Marine served until selected for promotion. The Kolmogorov-Smirnov test was used in the Risk Simulator, and the data points for each grade were evaluated to determine the best distributional fit of the sampled data. The chosen distributions and their associated parameters are shown in Table 3 and Table 4.

Table 3. Distributional Fit of Promotion Probabilities (1993–2013)

Promotion To	Probability of Promotion	Fitted Distribution (Parameters)	Parameter 1	Parameter 2	Parameter 3
1stLt	100.00%	Uniform (Max,Min)	1.0000	1.0000	
Capt In Zone	96.16%	Power 3 (Location,Factor Alpha)	0.0000	1.0000	24.0718
Capt Above Zone	0.04%	Lognormal (Mean,Deviation)	0.0102	0.0153	
Maj In Zone	78.53%	Gumbel Minimum (Alpha,Beta)	0.8495	0.0543	
Maj Above Zone	0.81%	Lognormal (Mean,Deviation)	0.0436	0.0360	
LtCol In Zone	51.71%	Gamma (Alpha,Beta)	4.7349	0.0089	
LtCol Above Zone	1.15%	Gumbel Minimum (Alpha,Beta)	0.6718	0.0339	
Col In Zone	26.64%	Uniform (Min,Max)	0.4720	0.5360	
Col Above Zone	0.79%	Exponential (Location, Lambda)	0.0161	65.5240	

Table 4. Distributional Fit of Time in Grade (Years) (1993–2013)

Promotion To	Time in Grade (Years)	Fitted Distribution (Parameters)	Parameter 1	Parameter 2	Parameter 3
1stLt	2.0	Uniform (Max,Min)	2.0000	2.0000	
Capt In Zone	1.4	Gumbel Minimum (Alpha,Beta)	1.5481	0.3952	
Capt Above Zone	2.6	Logistic (Alpha,Beta)	2.6104	0.2473	
Maj In Zone	4.8	Lognormal (Mean,Deviation)	4.6910	0.4396	
Maj Above Zone	5.8	Lognormal 3 (Shift, Mean,Deviation)	5.7638	0.5369	0.1121
LtCol In Zone	4.5	Lognormal 3 (Shift, Mean,Deviation)	4.5394	0.2472	0.0695
LtCol Above Zone	6.1	Logistic (Alpha,Beta)	6.1059	0.3168	
Col In Zone	5.6	Triangluar (Min,MostLikely,Max)	4.0651	4.2200	4.7000
Col Above Zone	5.6	Lognormal 3 (Shift, Mean,Deviation)	5.5553	0.2631	0.0578

While the promotion and time in grade rates over the sampled 20-year period were fairly steady, there was variance in their values. Using just the average promotion rate for a given rank would lead to deterministic forecasting that does not account for the variance in the values (Mun, 2006, p. 318). A dynamic sampling of the promotion opportunities will be used to account for the variance in probabilities and yield a greater confidence in the validity models outputs. The result of this method yielded a distribution of expected outcome from which a confidence interval could be chosen to suit individual preferences.

2. Career Simulation Model

With the sample career statistics described above, a career simulation model was created in Excel. The career path simulation model is shown in Figure 4 and is explained for each area of the model. The fitted distributions were used to simulate both career longevity as well as the likelihood of promotion throughout a career using Monte Carlo simulation. The simulation was randomly seeded and run for 6,000 iterations. Two separate simulations were run. The first was for an O1, 22 years old, with no previous service. The second was for an O1E, 24 years old, with 6 years of prior service. All other inputs remained the same. It was necessary to create two separate runs because O1s and O1Es have different career starting points in terms of initial pay and years of service. The breakdown for each drawdown parameter for simulated careers that fall short of a 20-year retirement will be reviewed in the analysis.

Career Simulatiom

Promotion		Probability Simulation		Promotion Simulation		Linked Promotions		TimeInGrade Simulation		Career Simulation
From	To	InZone	AboveZone	InZone	AboveZone	InZone	AboveZone	InZone	AboveZone	
O1	O2	100%		1		1		2.0		2.0
O1E	O2E	100%		0		0		2.0		0.0
O2	O3	96.16%	0.043%	1	1	1	0	1.4	2.6	1.4
O2E	O3E	96.16%	0.043%	0	0	0	0	1.4	2.6	0.0
O3	O4	78.53%	0.81%	1	1	1	0	4.8	5.8	4.8
O3E	O4	78.53%	0.81%	1	1	0	0	4.8	5.8	0.0
O4	O5	51.71%	1.15%	1	1	1	0	4.5	6.1	10.1
O5	O6	26.64%	0.79%	0	0	0	0	5.6	5.6	0.0
O6								3.0	3.0	0.0
								Total Commissioned Yrs		18.2

Figure 4. Career Longevity Simulation Model

a. *Section 1: Initial Accession*

Officers commissioned as second lieutenants are automatically selected for promotion to first lieutenant with promotion effective after two years of time in grade, with good service (CMC, 2001). They are modeled with 100 percent promotion for all simulation runs and automatically credited two years of service for career longevity. Career path uncertainty begins with selection for promotion to captain.

b. *Section 2: Career Uncertainty*

For each run of the simulation, a promotion probability was randomly sampled from the distributions chosen above for each grade and selection zone O3/O3E through O6. Section 1 and Section 2 are essentially the promotion probability tree in tabular form.

c. *Section 3: Promotion Zones*

An officer has two opportunities to be selected for promotion before being passed over twice. After being twice passed for promotion, an officer will normally be discharged from active duty at the first available opportunity either by involuntary separation or mandatory retirement, if eligible. This section models the in-zone and above-zone promotion opportunities using a Bernoulli distribution to represent success and failure. The sampled in-zone and above-zone promotion probabilities were used as the success probability in the distribution. Successful promotions were represented as binary 1 and failure as binary 0.

d. Section 4: Linked Promotions

This section ensures continuity of promotion of O1E to O3E or O1 to O3. It ensures that a simulated promotion is only effective if the officer has been promoted to all previous grades as well. Additionally, it checks to ensure in-zone promotions are credited as successful before above-zone promotions in the same grade.

e. Section 5: Time in Grade

This section takes a random sample from the time in grade distribution for the successful promotions and credits those sampled years in Section 6 if the promotion was effective. Analysis between time in grade and selection rate showed little correlation between the two variables for in-zone and above-zone promotions.

f. Section 6: Career Simulation

The time in grade for each promotion is credited in this section. If the officer has accumulated at least 18 years of service but fewer than 20 years, the officer will also be credited with the years of sanctuary in the grade to which the officer was last promoted.

g. Section 7: Commissioned Longevity

The career longevity was determined by taking the sum of sampled times in grade for effective promotions and adding it to the previous years of service from the model input. Careers that extend beyond 20 years are eligible for retirement. Careers that extend beyond 15 years but fewer than 20 are eligible for temporary early retirement. Officers who hold the rank or select rank of major with at least six years of active duty are eligible for voluntary separation pay. Captains and majors who are twice passed over must be selected for continuation to achieve 20 years of service.

G. CAREER COMPENSATION MODEL

1. Pay Increases

Once the career longevity profile was simulated, the career pay was determined. The basic pay used in the model was computed from the historic pay tables from the

Defense Finance and Accounting Service (DFAS). The historic and known pay increases from 1965 to 2017 were analyzed and fitted to forecast the pay increases for the future years beyond 2017. Multiple possible trendlines were examined and the exponential trendline shown in Figure 5 was chosen.

The 53 periods represented in Figure 5 are the actual data points from 1965 to 2017. The exponential trendline had the highest R-squared value, 0.5291, of all the nonlinear trendlines. The linear trendlines were discounted because they allowed negative pay increases, which was inconsistent with all of the historical data points. The trend analysis also forecasted the pay increases out for an additional 20 years to 2037. While it was acknowledged that forecasting beyond five years was ambitious, it was an assumption that allowed for the career pay of those officers whose simulated careers extended beyond 2017 to be modeled with a reasonable level of confidence. The fitted and forecasted pay increases from which the trendline is based are available in Appendix B.

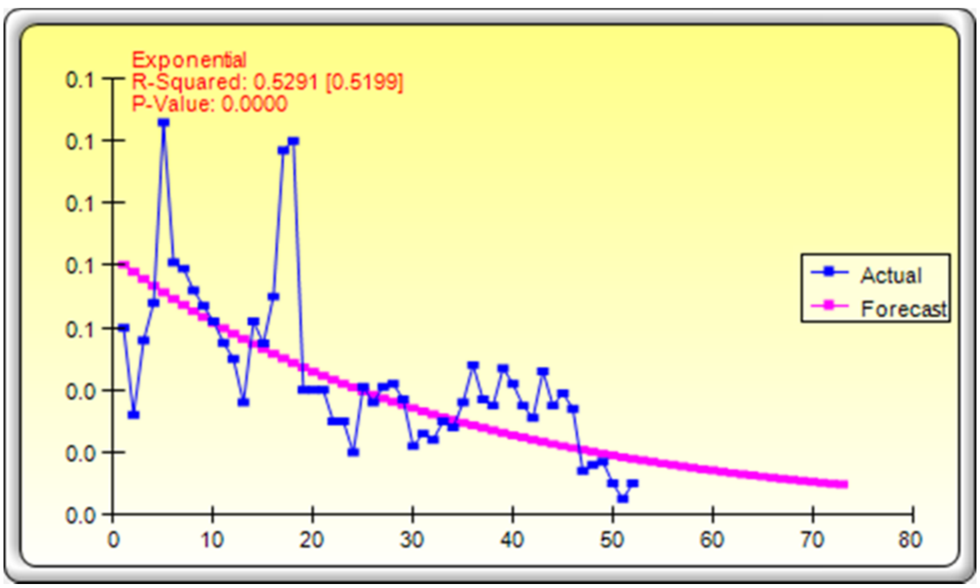

Figure 5. Actual and Forecasted Pay Increases (1965–2017)

2. Career Pay

The total career compensation is equal the sum of the monthly base pay for all months in grade for each grade held.

$$Career\ Compensation\ (grade, TIG) = \sum_{n=1}^{TIG} (BasePay_n)\ for\ all\ grades\ held$$

The basic pay is subject to change at the beginning of each calendar year due to annual pay increases as well with promotions to higher grades. A lookup table was used to determine the initial basic pay based on the officer's initial grade, OE or O1E, and accession year from the model's input section. The 1996 pay table was chosen as the initial starting point for all base pay determinations with the assumption that all officers who were accessed prior to 1996, still on active duty, will have the requisite number of years to be eligible for retirement benefits or be eligible for sanctuary status. They therefore would not be affected by the Marine Corps current drawdown parameters. A lookup function was executed using the officer's initial pay grade and years of service. The sum of all pay increases from 1996 to the officer's accession year was used to determine the initial base pay as well as all monthly pay during the simulated career.

H. INVESTMENT MODEL

The investment model uses the goal seek function to retroactively determine the monthly percentage and monthly contribution needed for an officer to meet retirement wealth goals based on the outcome of the simulated military career. It takes as its input the Marine's initial retirement savings, the nominal inflation rate, the desired rate of return on investments, terminal wealth goal, and income replacement ratio. A terminal wealth goal was assumed to be zero for both simulation runs, meaning the officer will have consumed the entirety of accumulated wealth in the retired years.

During the simulated career, if the Marine is determined to be within the affected population of career-designated officers, he or she will be discharged as the result of one of the drawdown parameters. Those that are not selected for continuation may be eligible to receive some compensation, either VSP or TERA benefits. Since these Marines have not reached the natural retirement age, the assumption is that this compensation will be used to fund their retirement investments or as replacement income.

Because the simulated careers will have different time horizons, income and wealth projections will have different relative values because of the time value of money

The net present value (NPV) measures the value of future dollars in current dollars (Cook, 2013). The use of the NPV allows for a reasonable comparison of different investment simulation iterations that have different time horizons. The NPV accounts for the risk that is expressed as the discounted rate. While the discount rate may not be precisely correct year to year for every investment, it is the generally accepted measure for forecasting the value of future dollars and provides consistency when comparing investment with similar risk exposure (Cook, 2013). The NPV is expressed as the sum of all cash flows, R_t, discounted by the given rate, $\boldsymbol{i}$, at period, $\boldsymbol{t}$, for all periods (Cook, 2013):

$$NPV(i,N) = \sum_{t=1}^{N} \left(\frac{R_t}{(1+i)^t}\right)$$

All wealth forecasts were expressed in terms of the NPV. The investment periods varied based on the difference between the Marine's expected military retirement age and the natural retirement age of 62. All credited military active duty and retirement payments were recorded in actual dollars since they were already adjusted for inflation.

I. POST–MILITARY CAREER INCOME

The career longevity from career simulation is used to determine the Marine's age at time of discharge from the military. Once the Marine has completed his or her military career, the assumption was made based on previous studies that the Marine will continue to work until the natural retirement age. The age chosen for the model was 62, the age at which 95 percent of workers leave the workforce and permanently retire (Maestas, 2009). This age is also an input to the model that can be adjusted to fit the Marine's preferences.

The income accrued during a post–military career will be assumed to be the equivalent civilian income necessary to maintain, at a minimum, the same standard of living afforded by the military income.

J. RETIREMENT MODEL

A payout table was generated to capture the monthly income, investments, withdrawals, and net accumulated wealth after each iteration in the simulation. The payout table is broken into three distinct areas.

The active duty working years, labeled as “Military,” covered all periods of projected military service. The income earned during the active duty years is based on military base pay only. The model will invest a portion to fund the officer’s retirement.

The nonactive duty working years, labeled as “Working,” covered the time period between the end of military service and the beginning of natural retirement. The income earned in the nonactive duty years was a portion of the officer’s active duty pay determined by the income replacement ratio. The amount depended on whether the officer earned retirement eligibility.

The retired years, labeled as “Retired,” are the remaining years from the natural retirement age to the terminal age. No money was earned during this period, unless the Marine reached retirement eligibility. The amount of money withdrawn from retirement savings was the percentage of retirement income replacement of the highest monthly pay earned in the nonactive duty working years, typically the last working month. The replacement ratio chosen for this simulation was 70 percent.

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IV. ANALYSIS

A. MODEL VALIDITY

Before the results of the model were analyzed, an association was drawn between the career longevity of the theoretical results from the model's output and the actual career longevity of a random sample population of officers from TFDW. The officers within the sample population that met the same criteria of officers that were excluded from the model based on the assumptions were also excluded from the queried sample.

The model simulates career paths for careers that span the years from 1996 through 2037, inclusively. Simulations of career paths that included years from 1996 to 2013 were based on promotion probabilities from a known year's data, while simulations that included years from 2014 to 2037 were theoretical. To determine the validity of the model's theoretically forecasted outputs, simulations were run for the career paths of second lieutenants who began their careers in 1996 and compared with the TFDW queries of the actual career paths of second lieutenants who began their careers in 1996. A strong correlation between the known career paths and modeled career paths would provide confidence in the model's validity.

The comparisons are shown in Table 5 and described below. The TFDW query is based on the number of officers accessed during FY1996. The initial model simulation was run for 6,000 iterations for the accession of a second lieutenant, O1 in 1996.

In all, the Marine Corps accessed 1,149 second lieutenants during fiscal year 1996, per the TFDW query of FY1996 quarterly sequence numbers. Of those, 955, or 83 percent, were offered career designation from which 47 declined to accept. The overall acceptance rate was 95 percent.

The career paths of those FY1996 officers who accepted career designation were followed by querying promotion and discharge entries for the subsequent TFDW sequence numbers up to FY2013. All officers were either discharged or currently remain on active duty. Of those accessed, 20 percent remain on active duty, all at the rank of lieutenant colonel (O5) with an average of 17.40 years of service. The remaining 80 percent have all been discharged by either separation or retirement. Of those, 44 percent served to the rank of major with 10.14 years of commissioned service, 83 percent served to the rank of captain with 4.06 years of service, and 96 percent served up to the rank of first lieutenant with 2.00 years of service. A total of 51 second lieutenants were discharged prior to being promoted to first lieutenant for physical disability or other administrative reasons.

The model assumes that each officer has accepted career designation and does not consider the officers who were discharged voluntarily before career designation or as a result of the career designation process. The promotion probabilities used in this study are reflective of those officers who desired continued service to reach retirement eligibility. The career paths of officers who separated voluntarily prior to achieving retirement eligibility were not considered.

After promotion to O4, the percentage of officers promoted begins to vary increasingly between the TFDW queried data and the model's output. The model assumes that a Marine officer will desire to continue service even after achieving retirement eligibility. In reality, there will be a sharp increase in the number of officers that will choose to retire upon reaching retirement eligibility. The higher promotion rates in the modeled data reflect the promotions of those officers who remain on active duty after achieving retirement eligibility.

Based on the comparison of the model output for the known year's data and an understanding of the variances due to voluntary attrition, the model was used to make determinations for the forecasted years beyond 2013.

Table 5. TFDW Model Comparison FY1996 Accessions

	TFDW Query 1,149 actual Marines		Model Simulation 6000 iterations	
Grade	**Years of Service**	**% Promoted**	**Years of Service**	**% Promoted**
O1	0.00	95.04%	0	100%
O2	2.00	96.24%	2.0	96.16%
O3	4.06	82.71%	4.61	78.53%
O4	10.19	44.24%	10.42	51.71%
O5	16.69	20.40%	16.54	26.64%
O6	N/A	N/A	Not modeled	Not modeled

B. CAREER LONGEVITY

As previously mentioned, it was necessary to distinguish between the career paths of O1 and O1E second lieutenants for the analysis because they will have different career staring points in terms of initial pay and years of service. The O1 was modeled with a starting age of 22 and no prior active service. The O1E was modeled with a starting age of 24 with six years of prior active service. The date of accession for both was 1 January 2000. The modeled career longevity for both career paths is shown in Figure 6.

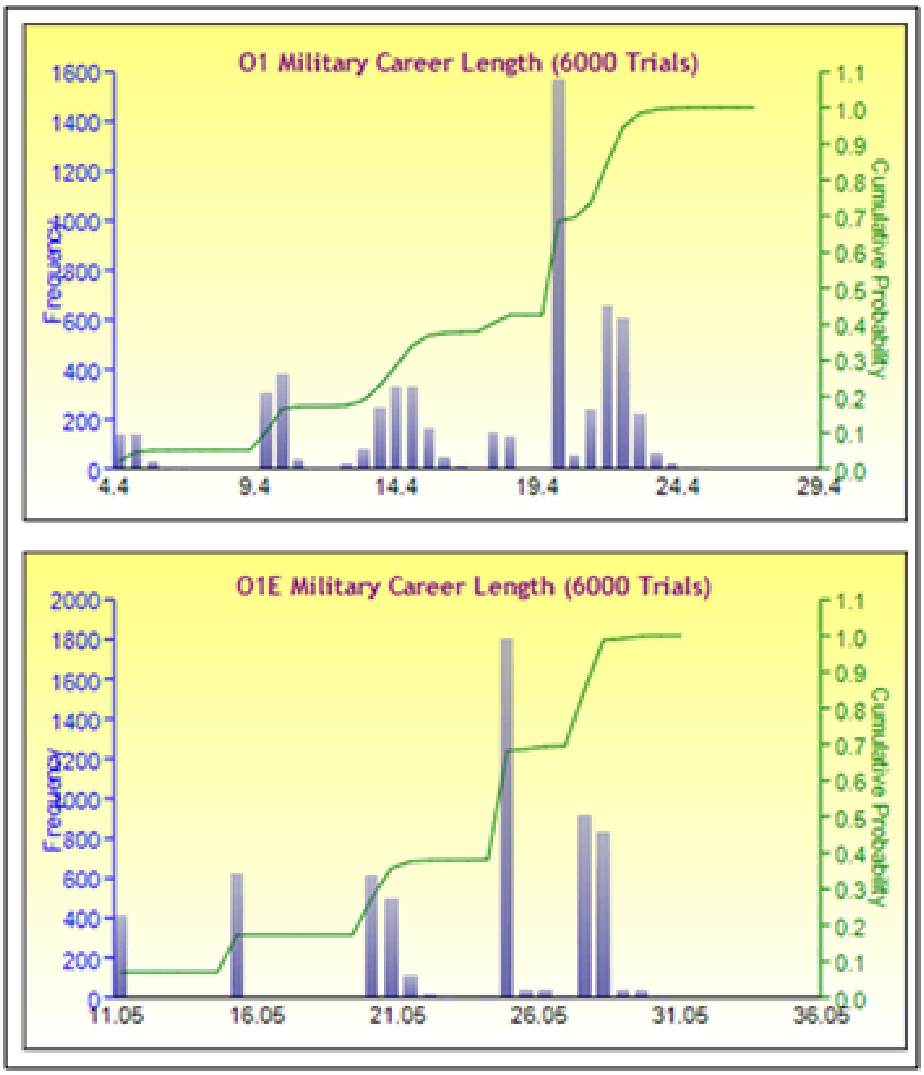

Figure 6. Modeled Career Longevity

The result was a multinode normal disrtibution for both career paths. The nodes corresponded with an officer being twice passed over for selection to the next grade. Each node is representative of a grade beginning with promotion to O3, which was the start of promotion uncertainty. The output is placed in three categories: Category A, the probabilitay of serving fewer than 15 years; Category B, the probability of serving more than 15 years and fewer than 18 years; and Category C, the probability of serving more than 18 years. Although 20 years of service is the requirement for retirement eligibility, those that reach sanctuary at 18 years were modeled with the appropriate number of years to achieve 20 years of service in their final grade and were counted with those that achieved retirement eligibity without sanctuary.

A large spike was observed in the O1 career path at the 20-year mark. This was interepreted as the number of Marines who reach sanctuary and were extended to 20 years to achieve retirement eligibility. The actual number will be higher since a larger number of officers will choose to retire upon reaching retirement eligibility as indicated by the TFDW query of actual career paths.

There were roughly 6.9 percent of the O1s expected to be discharged in Category A with an avergage of 10.6 years of service. This is comparable to 6.7 percent of the O1Es who were expected to serve 11.1 years. For the career paths, 10.4 percent of the O1s were category B with 15.2 years of service, and 10.3 percent of the O1Es were category B with 15.1 years of service. The remaining reached retirement eligibility.

1. Discharge Age

The modeled output and percentages for the discharge age shown in Figure 7 are similar to the output for longevity. This intuitively follows because the discharge age is function of the career longevity. This discharge age is important however when considering time horizon and the contribution level needed to fund the retirement. The O1s in category A were separated with an average age of 27.8 years compared to 29.8 for O1Es. The O1s and O1Es in Category B were discharged with an average age of 37.5 years and 35.5 years, respectively. The retirement eligible age began at 41.3 years for the O1Es and 42.2 for the O1s

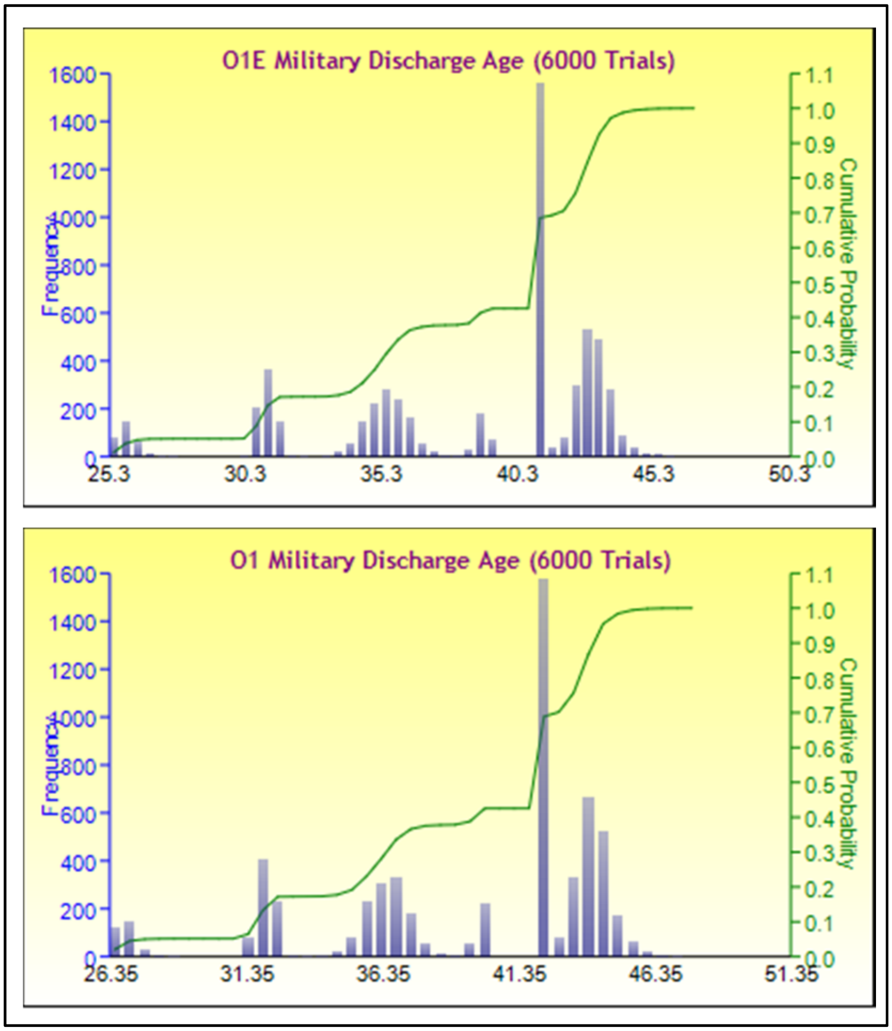

Figure 7. Modeled Discharge Age

C. MONTHLY CONTRIBUTION

1. Baseline Contribution

Both career path results from the simulation showed similarities with the expected contribution percentages an officer should make to successfully fund retirement. As shown in Figure 8, a bimodal normal distribution began to form for both career paths.

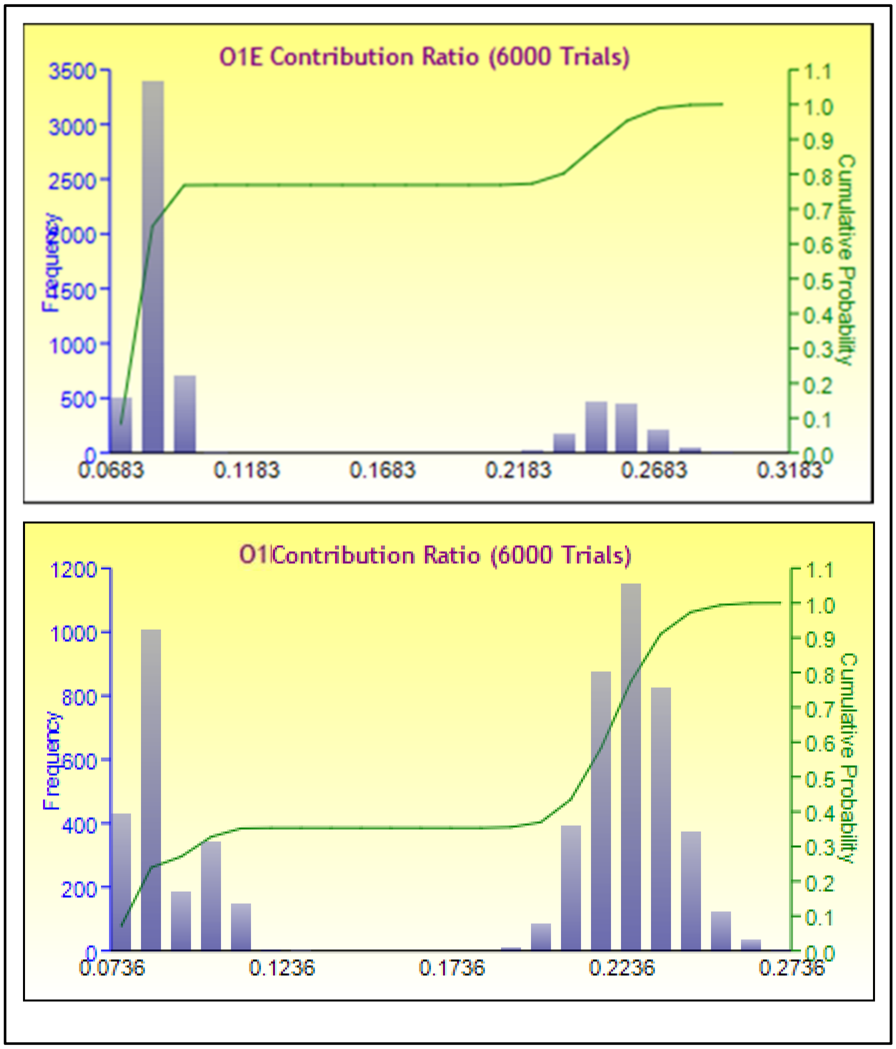

Figure 8. Baseline Monthly Contribution Rate

For the O1E career path, roughly 80 percent of the 6,000 iterations normalized around 8.1 percent while the remaining 20 percent normalized around 23.2 percent contribution rate. The O1 career path also had a bimodal distribution. However just under two-thirds of the iterations normalized around the higher 23 percent contribution rate and one-third around 9.8 percent. The lower contribution rates for both career paths correspond with officers achieving retirement eligibility and the benefit of expected retirement compensation.

The higher rates are associated with officers who were discharged with no retirement benefits and thus required a higher level of contribution during their working years to achieve the same terminal retirement goal. Because of the disparity in the contribution percentages between the two career paths, it was concluded that O1Es reach retirement eligibility at a higher rate. This follows intuitively as well because of the initial boost to their longevity provided by their years of previous service. Therefore, O1s should contribute at a higher rate earlier in their careers to increase the likelihood of funding their retirements and make reasonable adjustments through their careers as the uncertainty is reduced.

2. TERA Impact

To determine the effect of an officer accepting early retirement on the officer's ability to fund retirement, the model was run with the same parameters as the baseline. For this simulation, however, the retirement pay was computed using the TERA computation for those eligible officers in Category B and compared to the Category A and Category C officers.

With the TERA allowed as an option in the model, a dramatic shift in the contribution rate for both O1s and O1Es was apparent. The results, depicted in Figure 9, show a shift from 37 percent to nearly 50 percent of the O1s expected to be able to fund their retirement with TERA benefits. Nearly 92 percent of all of the O1E iterations were expected to be able to fund their retirement at the lower contribution rate compared to just 80 percent without the TERA option.

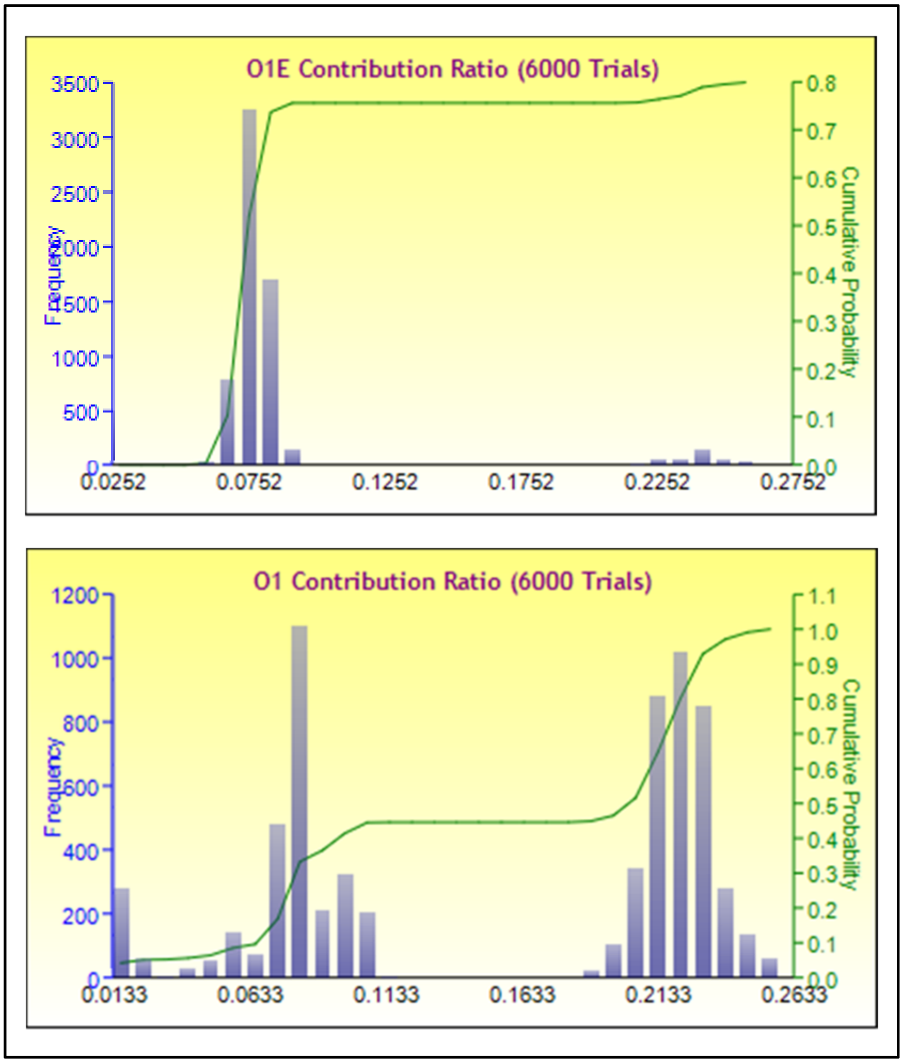

Figure 9. Contribution Rate with TERA Option

3. VSP Contribution Rate

To determine the effect of accepting VSP on an officer's ability to fund retirement, the model was run with the same parameters as the baseline. For this simulation, only discharges that were the result of separation with entitlement to VSP were observed. The VSP payment was added to the investment contribution at the time of separation.

There were a number of O1s that were eligible for the VSP benefit. Figure 10 shows that only 246 of the 6,000 iterations, or 4.1 percent, registered eligibility for VSP contribution. The amount of the contribution was normally distributed and centered on $158,000. The mean contribution rate with the VSP benefit was reduced from the 23.2 percent baseline to 6.2 percent. This is slightly less than the contribution rate for the officers that were eligible for retirement.

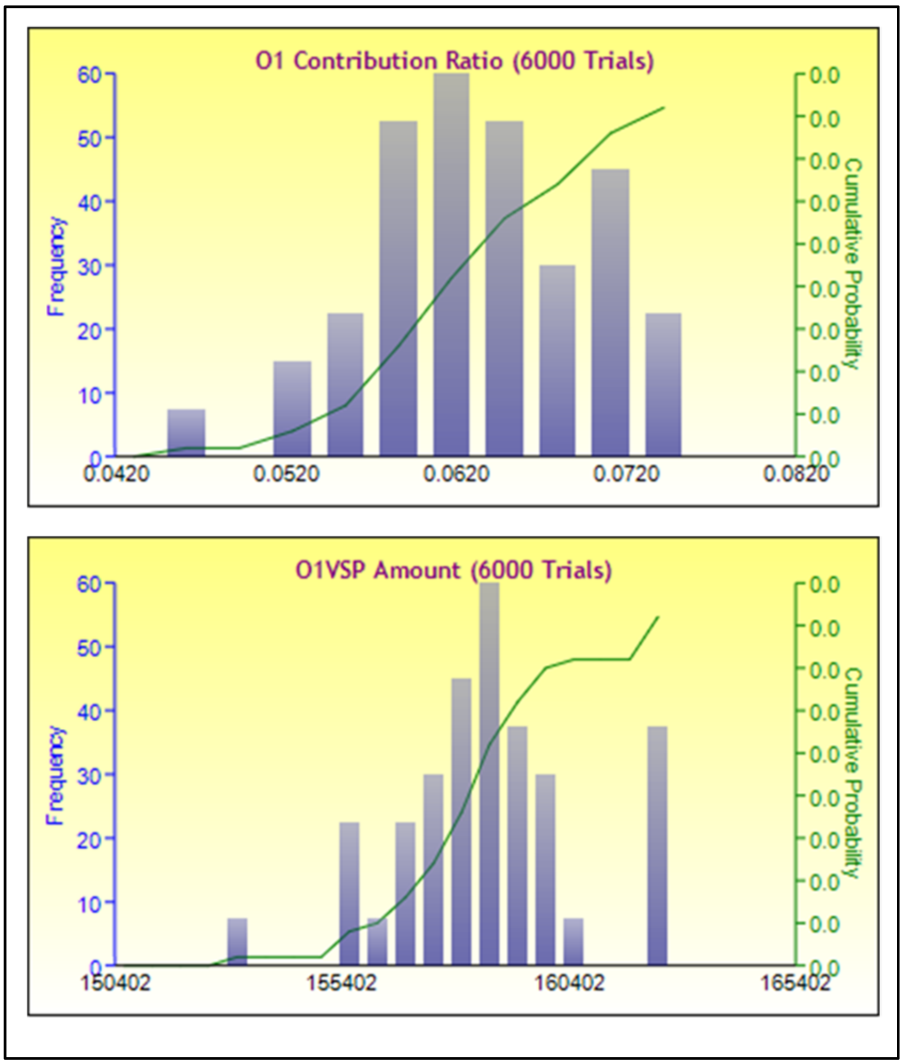

Figure 10. O1 VSP Amount and Contribution Rate

With the VSP option active, there were no iterations of O1Es that were eligible for the benefit. The model input for O1E included a conservative estimate of 6 years of prior active service. The requirement for the VSP is promotion or selection to O4. The model only adds time in service for a simulated promotion. The model does not allow for intermediate accumulation of time in service for periods before actual promotion. These periods of time are less discrete and difficult to model because each individual Marine will serve different periods of time while waiting to be promoted.

In reality there may be O1E career path officers that qualify for the benefit while waiting to be selected for promotion to major. The significance of the results was that that number will be at a much less rate than the 4.1 percent produced for O1 career path officers. This indicated that O1Es will be eligible for either TERA or statutory retirement benefits and at a much higher rate consistent with the baseline.

V. CONCLUSION

A. OVERVIEW

The Marine Corps plans to decrease its overall end strength by nearly 20,000 Marines by fiscal year 2016. This reduction will affect the careers all communities within the Marine Corps. This study focused on modeling the retirement and wealth probability of career-designated active duty officers because their career paths are the most linear of all populations. Even though this study only modeled one population of Marines, it has application to the others that will be affected.

A baseline career path distribution of career-designated officer was sampled from existing historical data from TFDW. The TFDW does not have the ability to readily query the actual career pay and entitlements earned by the affected population. The basic monthly pay for each grade was compiled from historical pay charts. A distributional fit using the Kolmogorov-Smirnov test was conducted. The historical promotion and probability statistics for each grade was compiled for historical promotion data and a distributional fit was applied.

During each simulation run, random samples from the fitted distributions were chosen for each input parameter to develop a career profile. The career profile considered promotions for each grade where the officer met the requisite time in grade requirements. The predicted monthly contribution was computed based on the simulated career path longevity. The simulation was run for 6,000 iterations. The outputs of the simulation were distributions of career longevity, discharge age, contribution rate, and VSP amount.

From the longevity and age distributions, the portion of officers discharged prior to reaching retirement eligibility was determined. It was determined that O1 will retire on average 2–6 years later than O1Es. For this target population, a conventional retirement planning approach was applied to retroactively determine the investment contribution needed during the Marine’s career to meet retirement goals. Without the benefit of VSP benefit, the mean contribution rate rose to 23.1 percent compared to

6.1 percent with the benefit. However, only 4.1 percent of the officers will even qualify for the VSP benefit.

The benefits provided by the VSP and TERA program are significant enough to allow members of the affected populations to fund their long-term retirement goals given wise investments with consistent rates of return. The issue as pointed out in this study is that the percentage of officers that will actually be eligible for those benefits is relatively low, in particular those officers in the O1 career path.

The Marine Corps will use the combined effects of all of the parameters to reach its desired manpower end strength. The modeling and simulation does, however, offer the individual Marine officer some statistical outcomes of the Marine Corps officer career longevity and promotion probability. This will offer the ability to make informed career and retirement investment decisions earlier.

B. RECOMMENDATION

The formulated model was developed as a proof of concept to forecast the terminal wealth potential based solely on the officer's accumulation of basic pay with the assumption that entitlements such as subsistence and housing allowances were applied, in whole, to those expenses for which they were intended. The risk of early career termination that Marines were exposed to as the result of imposed Marine Corps manpower drawdown parameters was modeled. An element of the wealth forecasting that was beyond the scope of this study was the internal risk tolerance of each Marine in the population. Marines with higher risk tolerance have the opportunity for greater variance in their wealth predictions, both positive and negative. The addition of a parameter that incorporates the individual investment preferences or risk tolerance will produce a model with greater accuracy for the individual Marine.

There are additional sources of hidden income that may be modeled as well. The lack of a requirement to pay state taxes as well as the variances in the amount of state taxes paid by many Marines presents the opportunity for additional hidden income in the form of a reduced expense that may be invested throughout a Marine's career. This additional income could have a dramatic effect on the forecasted contribution rates as well as the career decisions of the affected population. The addition of a simulated variable that models the distribution of historic state tax rates for each state would increase the accuracy of the model's output, but was beyond the scope of this study.

C. FURTHER STUDY

This study focused exclusively on the effects on the career longevity and working year contribution rates of active duty officers as the result of the manpower drawdown parameters imposed by the Marine Corps. The Army is in the midst of similar force reductions. This study may benefit both the Army and the other populations within the Marine Corps. The tools used in this study highlighted the utility of simulations to provide a broader distribution of model outcomes.

The figure caption for appendix A needs to be under the figure. You can landscape the page if you like or you can leave it like that and move the caption. Figure needs number. Recommend captions and numbers for other figures and tables in appendices. Give citations if needed.

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APPENDIX A

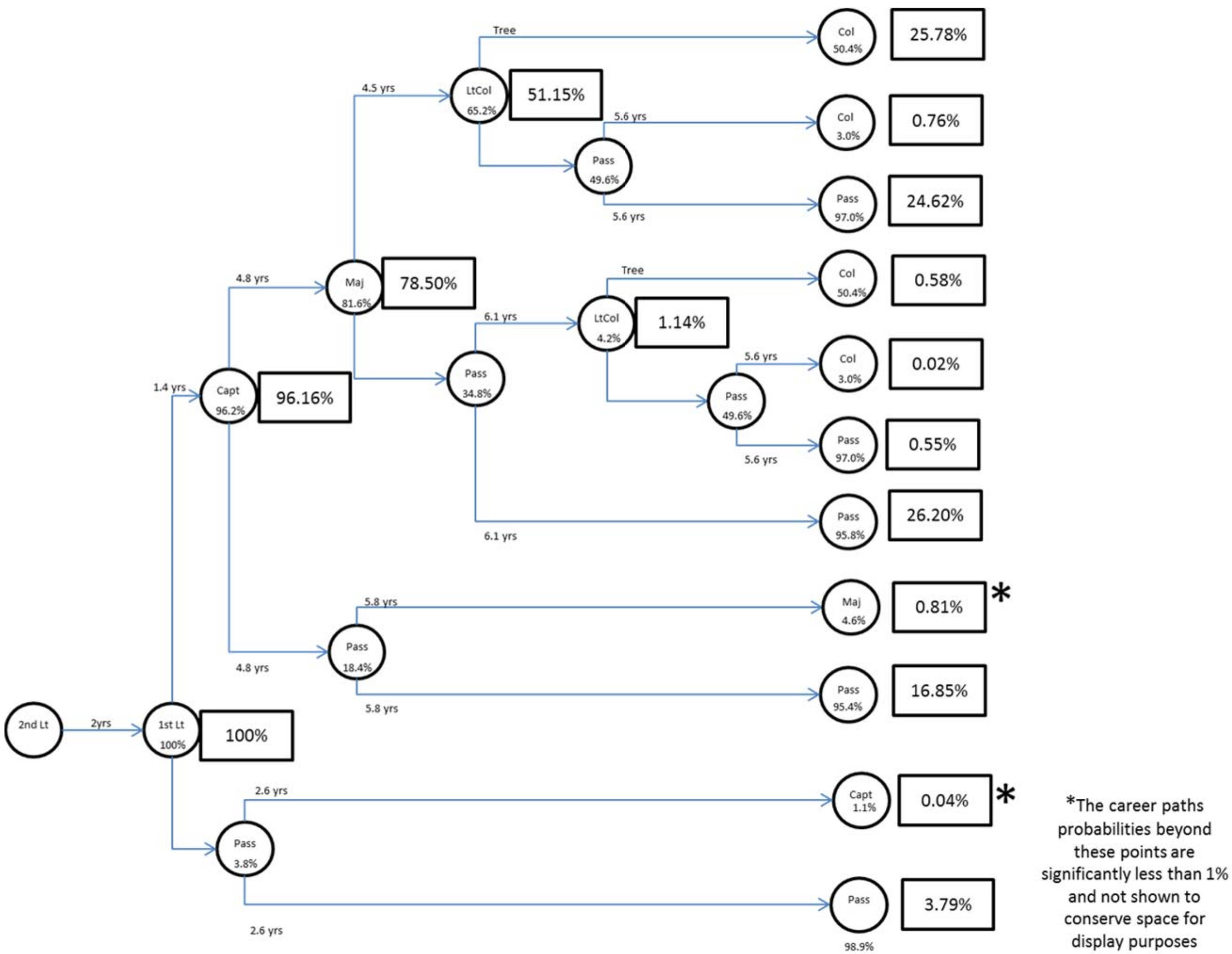

Figure 11. Career Path Probability Tree

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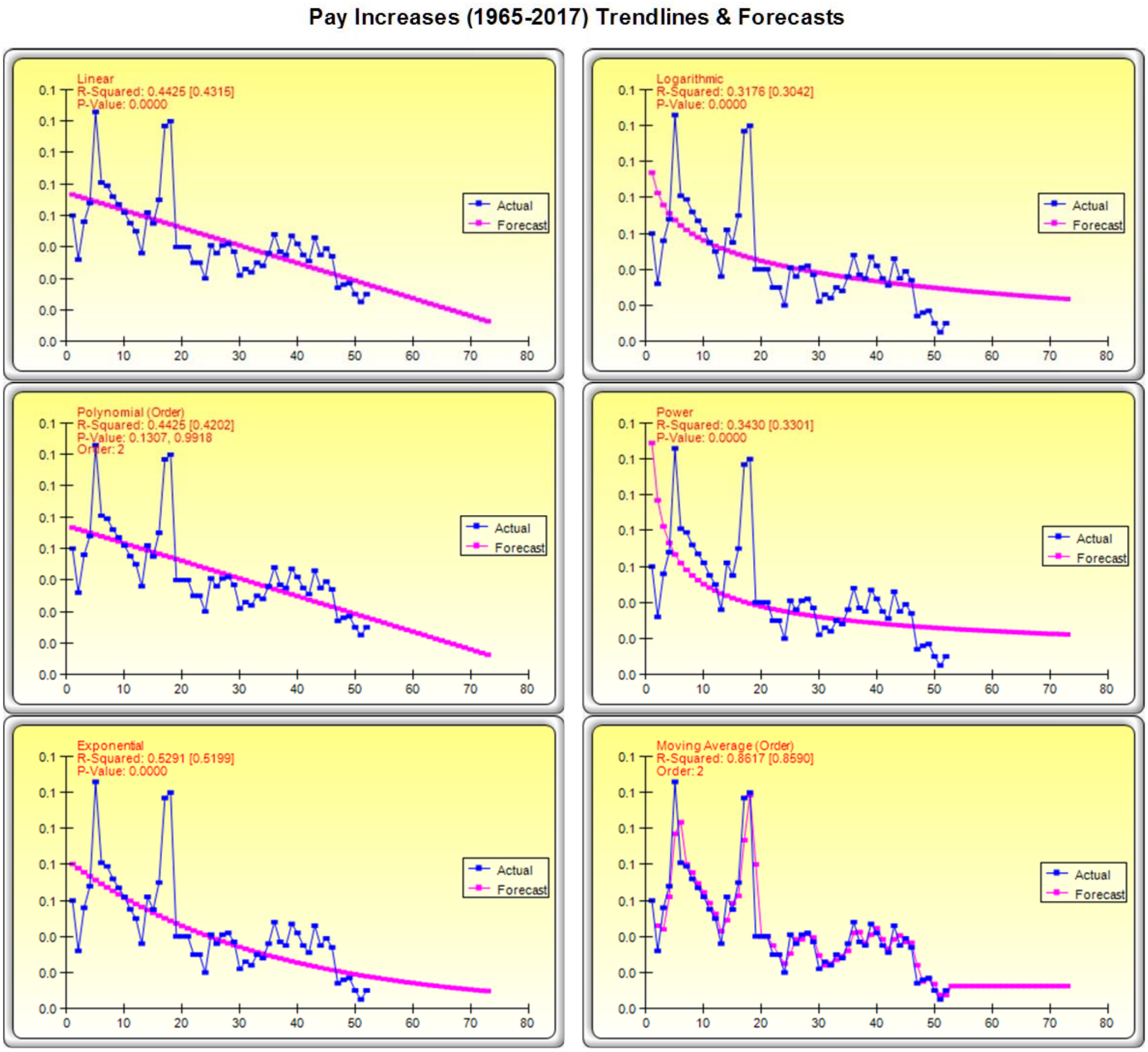
APPENDIX B



Pay Increases (1965-2017) Trendlines & Forecasts
Linear
R-Squared: 0.4425 [0.4315]
P-Value: 0.0000
Logarithmic
R-Squared: 0.3176 [0.3042]
P-Value: 0.0000
Polynomial (Order)
R-Squared: 0.4425 [0.4202]
P-Value: 0.1307, 0.9918
Order: 2
Power
R-Squared: 0.3430 [0.3301]
P-Value: 0.0000
Exponential
R-Squared: 0.5291 [0.5199]
P-Value: 0.0000
Moving Average (Order)
R-Squared: 0.8617 [0.8590]
Order: 2
Actual
Forecast

Pay Increases (1965–2037) Trendlines & Forecasts

Year	Actual Data	Linear	Logarithmic	Polynomial	Power	Exponential	Moving Average
1965	0.0600	0.0734	0.0939	0.0733	0.1290	0.0803	
1966	0.0320	0.0723	0.0825	0.0722	0.0971	0.0779	0.0460
1967	0.0560	0.0711	0.0759	0.0711	0.0822	0.0757	0.0440
1968	0.0680	0.0700	0.0712	0.0700	0.0731	0.0735	0.0620
1969	0.1260	0.0689	0.0675	0.0689	0.0667	0.0714	0.0970
1970	0.0810	0.0678	0.0645	0.0678	0.0619	0.0693	0.1035
1971	0.0790	0.0667	0.0620	0.0666	0.0581	0.0673	0.0800
1972	0.0720	0.0655	0.0598	0.0655	0.0550	0.0653	0.0755
1973	0.0670	0.0644	0.0579	0.0644	0.0524	0.0634	0.0695
1974	0.0620	0.0633	0.0561	0.0633	0.0502	0.0616	0.0645
1975	0.0552	0.0622	0.0546	0.0622	0.0483	0.0598	0.0586
1976	0.0500	0.0611	0.0531	0.0611	0.0466	0.0581	0.0526
1977	0.0360	0.0600	0.0518	0.0600	0.0451	0.0564	0.0430
1978	0.0620	0.0588	0.0506	0.0588	0.0438	0.0548	0.0490
1979	0.0550	0.0577	0.0495	0.0577	0.0425	0.0532	0.0585
1980	0.0700	0.0566	0.0484	0.0566	0.0414	0.0516	0.0625
1981	0.1170	0.0555	0.0474	0.0555	0.0404	0.0501	0.0935
1982	0.1200	0.0544	0.0465	0.0544	0.0395	0.0487	0.1185
1983	0.0400	0.0532	0.0456	0.0533	0.0386	0.0473	0.0800
1984	0.0400	0.0521	0.0448	0.0521	0.0378	0.0459	0.0400
1985	0.0400	0.0510	0.0440	0.0510	0.0371	0.0446	0.0400
1986	0.0300	0.0499	0.0432	0.0499	0.0364	0.0433	0.0350
1987	0.0300	0.0488	0.0425	0.0488	0.0357	0.0420	0.0300
1988	0.0200	0.0476	0.0418	0.0477	0.0351	0.0408	0.0250
1989	0.0410	0.0465	0.0411	0.0466	0.0345	0.0396	0.0305
1990	0.0360	0.0454	0.0405	0.0454	0.0339	0.0385	0.0385
1991	0.0410	0.0443	0.0398	0.0443	0.0334	0.0373	0.0385
1992	0.0420	0.0432	0.0393	0.0432	0.0329	0.0363	0.0415
1993	0.0370	0.0420	0.0387	0.0421	0.0325	0.0352	0.0395
1994	0.0220	0.0409	0.0381	0.0410	0.0320	0.0342	0.0295
1995	0.0260	0.0398	0.0376	0.0398	0.0316	0.0332	0.0240
1996	0.0240	0.0387	0.0371	0.0387	0.0312	0.0322	0.0250
1997	0.0300	0.0376	0.0366	0.0376	0.0308	0.0313	0.0270
1998	0.0280	0.0365	0.0361	0.0365	0.0304	0.0304	0.0290
1999	0.0360	0.0353	0.0356	0.0354	0.0301	0.0295	0.0320
2000	0.0480	0.0342	0.0351	0.0342	0.0297	0.0287	0.0420
2001	0.0370	0.0331	0.0347	0.0331	0.0294	0.0278	0.0425
2002	0.0350	0.0320	0.0342	0.0320	0.0291	0.0270	0.0360
2003	0.0470	0.0309	0.0338	0.0309	0.0288	0.0262	0.0410
2004	0.0420	0.0297	0.0334	0.0297	0.0285	0.0255	0.0445
2005	0.0350	0.0286	0.0330	0.0286	0.0282	0.0247	0.0385

Pay Increases (1965–2037) Trendlines & Forecasts (Cont.)

Year	Actual Data	Linear	Logarithmic	Polynomial	**Power**	Exponential	Moving Average
2006	0.0310	0.0275	0.0326	0.0275	0.0279	0.0240	0.0330
2007	0.0460	0.0264	0.0322	0.0264	0.0276	0.0233	0.0385
2008	0.0350	0.0253	0.0318	0.0253	0.0274	0.0226	0.0405
2009	0.0390	0.0241	0.0315	0.0241	0.0271	0.0220	0.0370
2010	0.0340	0.0230	0.0311	0.0230	0.0269	0.0214	0.0365
2011	0.0140	0.0219	0.0308	0.0219	0.0266	0.0207	0.0240
2012	0.0160	0.0208	0.0304	0.0208	0.0264	0.0201	0.0150
2013	0.0170	0.0197	0.0301	0.0196	0.0262	0.0195	0.0165
2014	0.0100	0.0185	0.0297	0.0185	0.0260	0.0190	0.0135
2015	0.0050	0.0174	0.0294	0.0174	0.0258	0.0184	0.0075
2016	0.0100	0.0163	0.0291	0.0163	0.0256	0.0179	0.0075
2017	0.0150	0.0152	0.0288	0.0151	0.0254	0.0174	0.0125
2018		0.0141	0.0285	0.0140	0.0252	0.0169	0.0125
2019		0.0130	0.0282	0.0129	0.0250	0.0164	0.0125
2020		0.0118	0.0279	0.0118	0.0248	0.0159	0.0125
2021		0.0107	0.0276	0.0106	0.0246	0.0154	0.0125
2022		0.0096	0.0273	0.0095	0.0244	0.0150	0.0125
2023		0.0085	0.0270	0.0084	0.0243	0.0146	0.0125
2024		0.0074	0.0268	0.0072	0.0241	0.0141	0.0125
2025		0.0062	0.0265	0.0061	0.0239	0.0137	0.0125
2026		0.0051	0.0262	0.0050	0.0238	0.0133	0.0125
2027		0.0040	0.0260	0.0039	0.0236	0.0129	0.0125
2028		0.0029	0.0257	0.0027	0.0235	0.0126	0.0125
2029		0.0018	0.0254	0.0016	0.0233	0.0122	0.0125
2030		0.0006	0.0252	0.0005	0.0232	0.0119	0.0125
2031		-0.0005	0.0249	-0.0007	0.0230	0.0115	0.0125
2032		-0.0016	0.0247	-0.0018	0.0229	0.0112	0.0125
2033		-0.0027	0.0245	-0.0029	0.0228	0.0109	0.0125
2034		-0.0038	0.0242	-0.0041	0.0226	0.0105	0.0125
2035		-0.0050	0.0240	-0.0052	0.0225	0.0102	0.0125
2036		-0.0061	0.0238	-0.0063	0.0224	0.0099	0.0125
2037		-0.0072	0.0235	-0.0074	0.0222	0.0096	0.0125

Error Estimates	
Method	RMSE
Linear	0.0192
Logarithmic	0.0213
Polynomial	0.0192
Power	0.0246
Exponential	0.0198
Moving Average	0.0098

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